

Time -

Let the no of boxes be B and in total n elements

Firstly we have to insert the elements into the boxes so now as all the elements might have mapped to same box so in worst case for a insertion you have to surpass $n-1$ before thus $O(n^2)$ this step

Now we are taking each such box where one have at worst n elements so the worst case to sort them will be $n \log n$

Otherwise the things can be divided among the boxes and one cannot have more than one n strings so if each of them m_1, m_2, \dots, m_n thus to sort them it will be $m_1 \log m_1, \dots$. So we will have some $B \cdot n \log n$ value

We push all the lists into a array thus we will have $O(n)$ time and a B multiple of it in worst case

After that we have N elements and quick sort $N \log N$ here N is the total number of elements in the final array obtained

Thus it would be $O(n^2) + O(B \cdot n \log n)$ (This B and n depend on how many boxes are there having elements and how many are those in a particular box) + $O(n \log n)$ for final sorting

Space -

$O(n^2)$ space as we are maintaining array of lists